

ABSTRACT

A single piezoelectric is excited at a first frequency to cause two vibration modes in a resonator producing a first elliptical motion in a first direction at a selected contacting portion of the resonator that is placed in frictional engagement with a driven element to move the driven element in a first direction. A second frequency excites the same piezoelectric to cause two vibration modes of the resonator producing a second elliptical motion in a second direction at the selected contacting portion to move the driven element in a second direction. The piezoelectric is preloaded in compression by the resonator. Walls of the resonator are stressed past their yield point to maintain the preload. Specially shaped ends on the piezoelectric help preloading. The piezoelectric can send or receive vibratory signals through the driven element to or from sensors to determine the position of the driven element relative to the piezoelectric element or resonator. Conversely, the piezoelectric element can receive vibration or electrical signals passed through the driven element to determine the position of the driven element. The resonator is resiliently urged against the driven element, or vice versa. Plural resonators can drive common driven elements.